भारतीय मानक
Indian Standard

IS 11330 : 2021

प्रशीतन तेल विभाजक — सामान्य विशिष्टि, निर्माण अपेक्षाएँ और परीक्षण

(पहला पुनरीक्षण)

Refrigeration Oil Separator — General Specification, Construction Requirements and Testing

(First Revision)

ICS 27.200

© BIS 2021

भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली – 110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
www.bis.gov.in www.standardsbis.in

August 2021 **Price Group 6**

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Refrigeration and Air Conditioning Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard was first published in 1985.

The major changes in this revision are as follows:

a) Additional terminology is added;

b) Types of oil separator is added;

c) Test method to determine oil separating efficiency is added; and

d) Data to be recorded is added.

The composition of the committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the rules of the test or analysis shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

REFRIGERATION OIL SEPARATOR — GENERAL SPECIFICATION, CONSTRUCTION REQUIREMENTS AND TESTING

(First Revision)

1 SCOPE

1.1 This standard covers the requirements and measurement methods for determining the oil separating characteristics of refrigerant discharge line oil separator with refrigerant in which the oils are partially or completely soluble.

This standard provides the requirements of refrigeration oil separator for the following:

a) Construction;
b) Capacity;
c) Oil separation efficiency; and
d) Safety requirements with reference to application temperature, pressure and different types of refrigerants.

This standard is applicable for oil separators used for refrigeration purpose only and provides particular requirements for different refrigerants types.

1.2 This standard does not cover the following:

a) It does not provide design guideline for construction;
b) Manufacturing process; and
c) Field installation and safety requirements.

2 REFERENCES

The following standards contain provisions which through reference in this text, constitute provisions of the standards. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS No.	*Title*
2825 : 1969	Code for unfired pressure vessels
3615 : 2020	Glossary of terms used in refrigeration and air conditioning (*second revision*)
ISO 14903 : 2017	Refrigerating systems and heat pumps — Qualification of tightness of components and joint
16678 (Part 2) : 2017/ISO 5149-2 : 2014	Refrigerating systems and heat pumps safety and environmental requirements: Part 2 Design, construction, testing, marking and documentation

3 TERMS AND DEFINITIONS

For the purposes of this standard, the terms given in IS 3615, and in addition following definitions listed below shall apply:

3.1 Standard Air — Dry air at 20 °C and at a standard barometric pressure of 101.325 kPa, having a mass density of 1.204 kg/m^3.

3.2 Refrigeration Oil Separator — A device for separating oil and oil vapor from the refrigerant, usually installed in the compressor discharge line.

3.3 Design Pressure (P) — The maximum allowable working pressure for which a specific part of a system is designed.

3.4 Operating Pressure — The pressure which is required for the processes served by the vessel at which the vessel is normally operated.

3.5 Maximum Allowable Working Pressure (MAWP) — The internal pressure at which the weakest element of the vessel is loaded to the ultimate permissible point.

NOTE — Design pressure can be equal or less than the MAWP.

3.6 Design Temperature — The minimum allowable working temperature that any part of the oil separator is likely to attain in the course of operation.

3.7 Maximum Allowable Stress Values (S) — It is the maximum allowable stress value of the material of construction at design temperature.

NOTE — Refer IS 2825

3.8 Construction Terminology

3.8.1 *Shell Thickness* — Shell is the cylindrical part of oil separator. Shell is usually made of carbon steel material.

NOTE — All vessels, pipe lines and the like for carrying, storing or receiving steam, gases or liquids at pressure above the atmospheric pressure are defined as shell.

It is the thickness of the cylindrical shell and the dome or dished head which is the critical design parameter in vessel design.

3.8.2 *Joint Efficiency Factor (E)* — It represents the effectiveness of the fabrication joints by welding or other means through the examination of the internal structure of the joints.

3.8.3 *Dome* — The upper and lower part of the oil separator welded on both sides of cylindrical shell. The constructional shape is usually of hemispherical, ellipsoidal, tori-spherical shape.

NOTE — It is also referred to as dished head.

3.8.4 *Baffles* — It is a separating channel specially designed to insulate the oil collection and eliminate the oil re-entrainment by preventing turbulence. Baffles are usually made of steel wire mesh or nylon.

3.8.5 *Float Valve* — This valve located in oil sump will allow the oil to return to the compressor as the volume of the collected oil level increases.

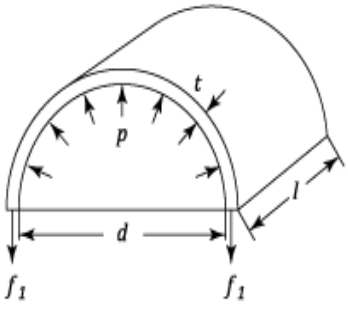
3.8.6 *Oil Sump* — It is the portion of oil separator which collects the oil removed from discharge refrigerant gas and returns the same to compressor.

3.9 Joint Efficiency Factor — It represents the effectiveness of the fabrication joints by welding or other means through the examination of the internal structure of the joints.

NOTE — Refer IS 2825 for classification and method of testing.

3.10 Circumferential Stress

The internal force exerting on the circumference of the shells and dome.



t – thickness

l – length

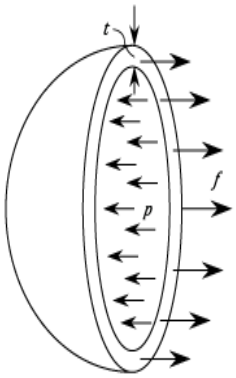
d – inner diameter of the shell

p – pressure

f_1 – stress

3.11 Longitudinal Stress

The internal force exerting perpendicular to the circumference of the shell.



t – thickness

p – pressure

f – stress

3.12 Corrosion Allowance — It is the amount of shell thickness allowance that should be considered for the corrosion as per the standard corrosion factors.

NOTE — Refer IS 2825 for details.

3.13 Radiography Inspection — It is a non-destructive method of testing where fabricated components can be examined to verify the internal structure and integrity of specimen using X-ray normally. The scope here is to examine the welding joint effectiveness. The Welding joint effectiveness is considered as 1 if it passes radiography inspection.

NOTE — Refer IS 2825 for details.

4 CONSTRUCTION

The types of oil separators are defined based on the construction and oil separation method used. This standard provides some of the typical and most commonly used oil separator constructions.

4.1 Impingement Type Oil Separator

In this type of oil separator, discharge gas enters the large volume of vessel impinging on the screen. Fine oil particles collide with one another and form heavier particles. Further the fine mesh screens separate the oil and refrigerant causing larger oil droplets to form and drop to the bottom of the separator. The collected oil is returned to the compressor through an oil return mechanism. Generally efficiency of this type of oil separator varies from 85 percent ~ 95 percent.

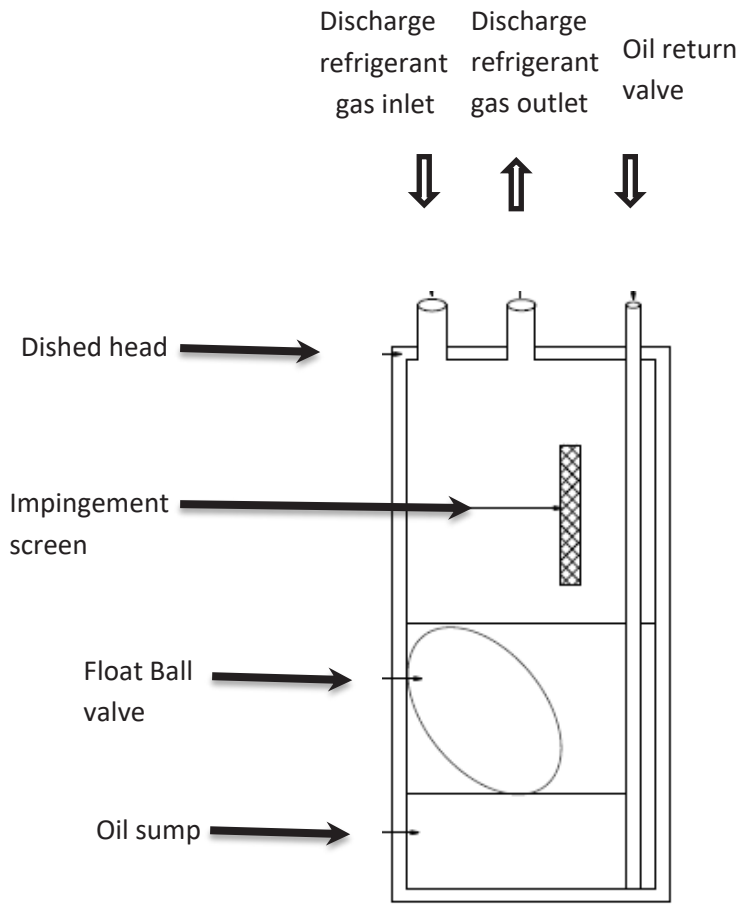


FIG. 1 IMPINGEMENT TYPE OIL SEPARATOR

4.2 Helical Type Oil Separator

In this type of oil separator, discharge gas impinges on a screen with high velocity due to centrifugal force developed by following a helical path in the vessel, thus separating gas and oil. Isolators are provided to separate oil sump from the flow path. Collected oil then returns to the compressor through oil return mechanism. Generally efficiency of this type oil separator is around 99 percent. It is also referred as cyclone oil separator or centrifugal oil separator.

4.3 Coalescing Type Oil Separator

In this type of oil separator, vessel uses a filter media like borosilicate glass fiber wound as oil retaining matrix. The discharge gas passes through filter matrix, oil molecules are excited causing them to collide with each other to form larger droplets which are forced to filter through outer drain layer and gets collected in the sump by gravity. Generally efficiency of this type of oil separator is around 99 percent and above.

4.4 Shell thickness – Typical Calculation

The shell thickness can be calculated as following:

4.4.1 For circumferential stress , longitudinal welds when (MAWP) P < 0.385SE and t < 0.5 R.

$$t = \frac{P \times R}{(S \times E) - 0.6P}$$

4.4.2 For Longitudinal stress, circumferential welds.

$$t = \frac{P \times R}{2(S \times E) + 0.4P}$$

where

t = Cylinder thickness in corroded condition, in m;

P = Design pressure, in kPa;

R = Cylinder inside radius in corroded condition, in m;

S = Maximum allowable stress at design temperature, kPa; and

E = Joint Efficiency.

NOTE — Refer to IS 2825, clause **3.3** for calculating shell thickens of cylindrical and spherical shells.

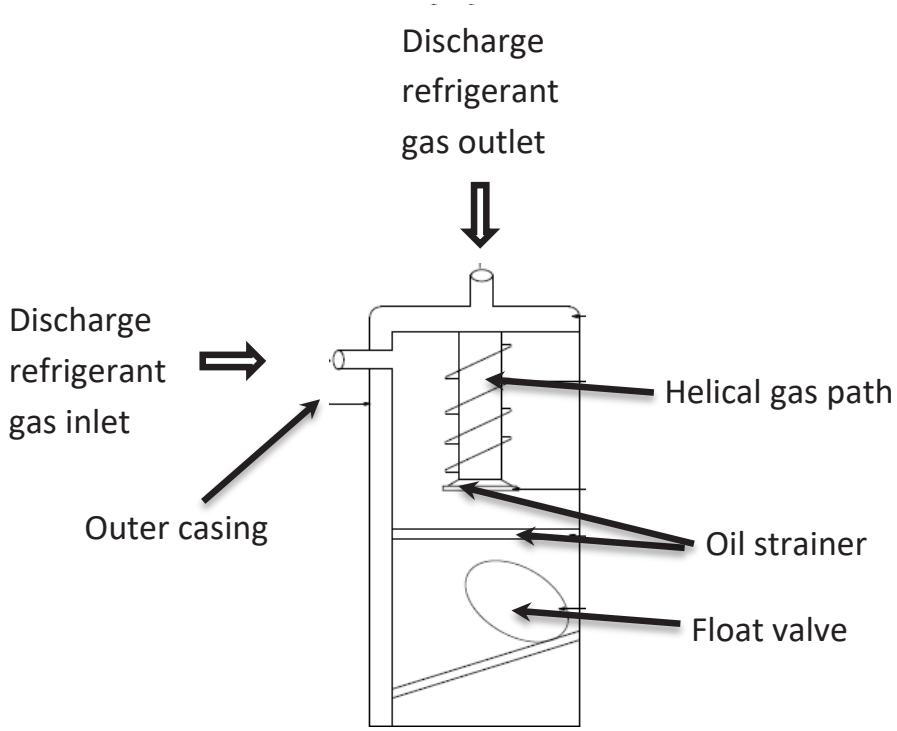


FIG. 2 HELICAL TYPE OIL SEPARATOR

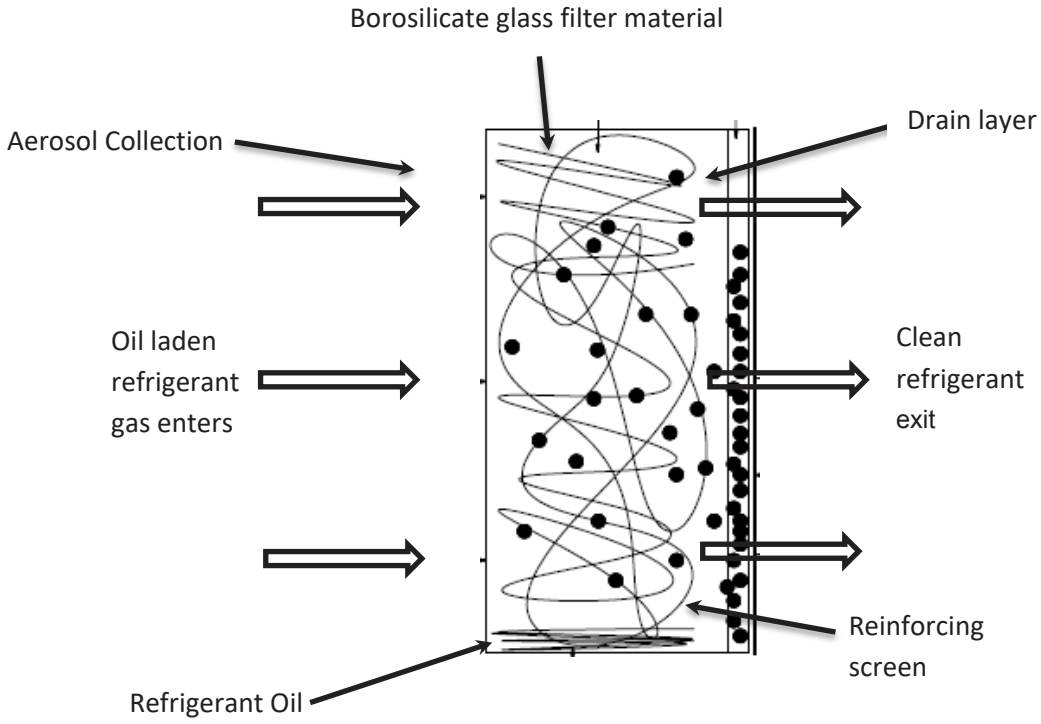


FIG. 3 COALESCING TYPE OIL SEPARATOR

4.5 Product Safety

4.5.1 The product safety shall be ensured by following design and material guidelines as per IS 16678-2/ISO 5149-2. The leak testing shall be done as per ISO 14903.

5 PERFORMANCE TESTING

Oil Separating Efficiency:

The test methods provides method for determining the oil separating efficiency for low oil flow rate and where the oil in vapor stream has oil concentration of 2 500 ppm or more.

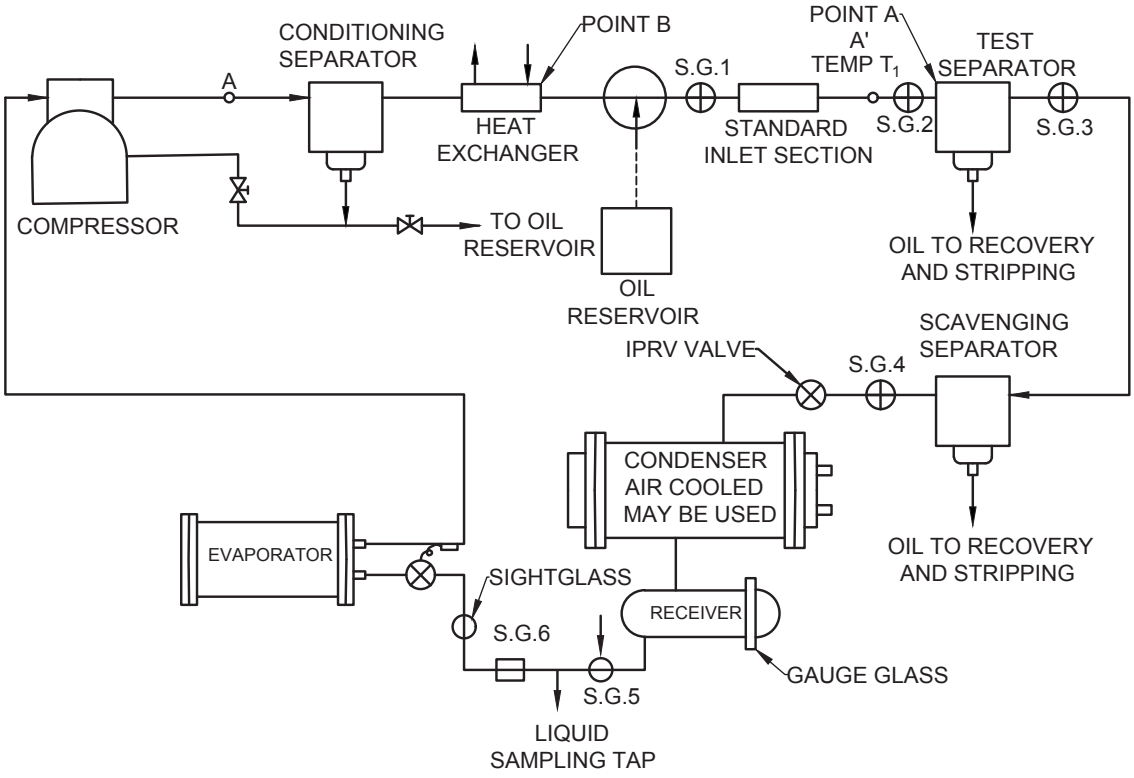
5.1 Test Set-up

The test set-up shall be as shown in the Fig. 4.

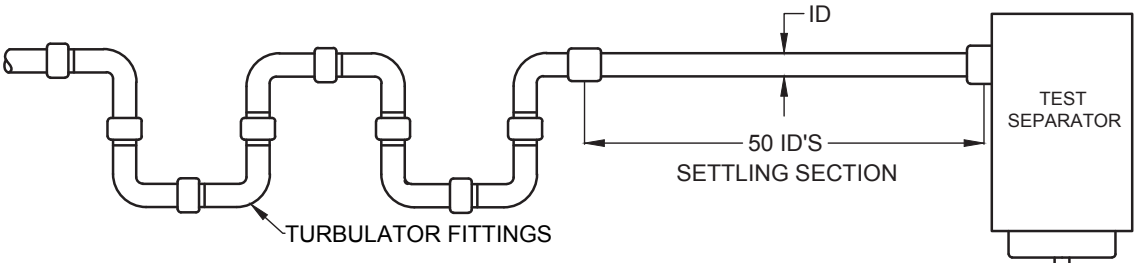
5.2 Equipment-Test Setup

5.2.1 *Compressor*

The compressor may be of any type to deliver desired range of refrigerant mass flow at range of discharge pressure and maximum oil carryover of 1.26×10^{-3} m^3/s.

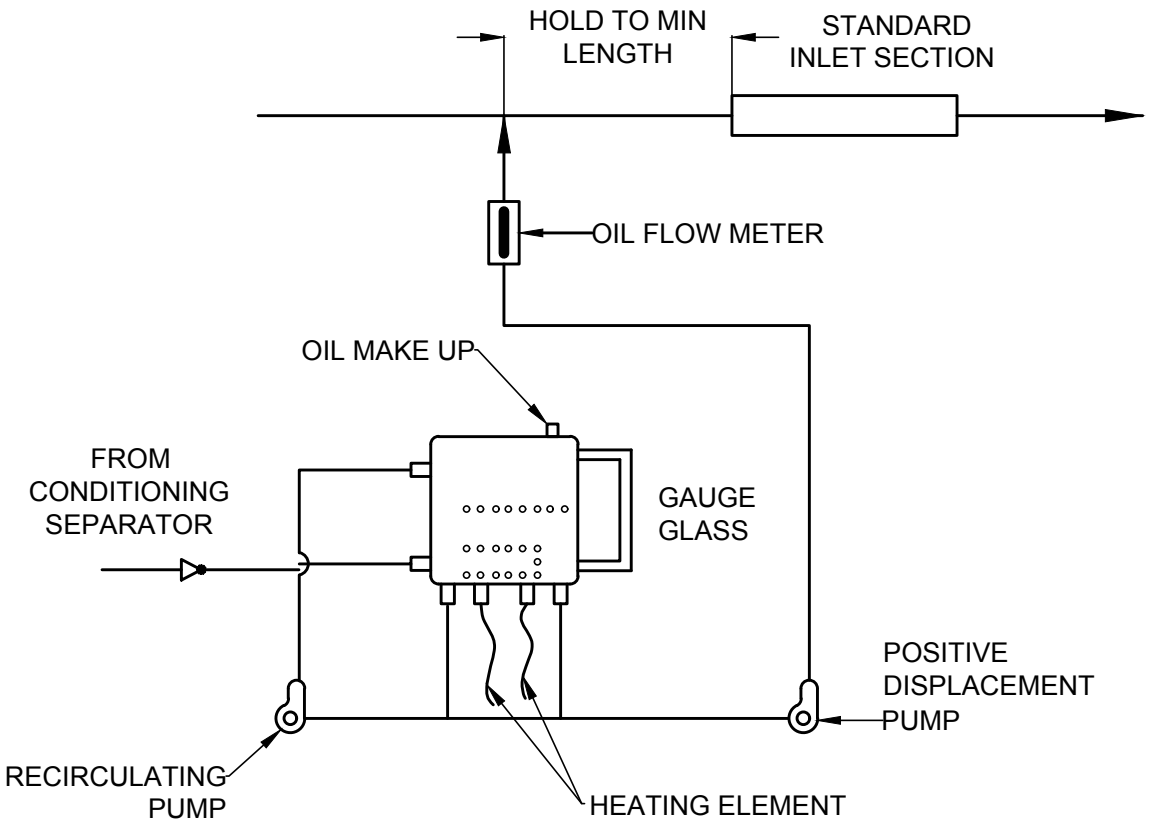


a) Test Setup

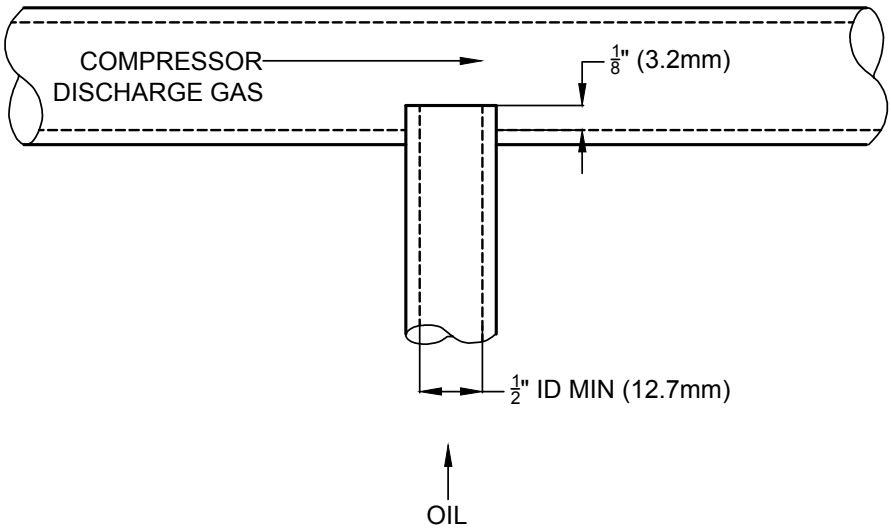


ALL FITTINGS AND TUBE OD TO BE SAME SIZE AS INLET CONNECTION TO TEST OIL SEPARATOR (TYPE L)
SETTLING SECTION TO BE IN HORIZONTAL PLANE
TURBULATOR FITTINGS TO BE IN VERTICAL PLANE WHEN TEST SEPARATOR INLET NOZZLE AXIS IS HORIZONTAL

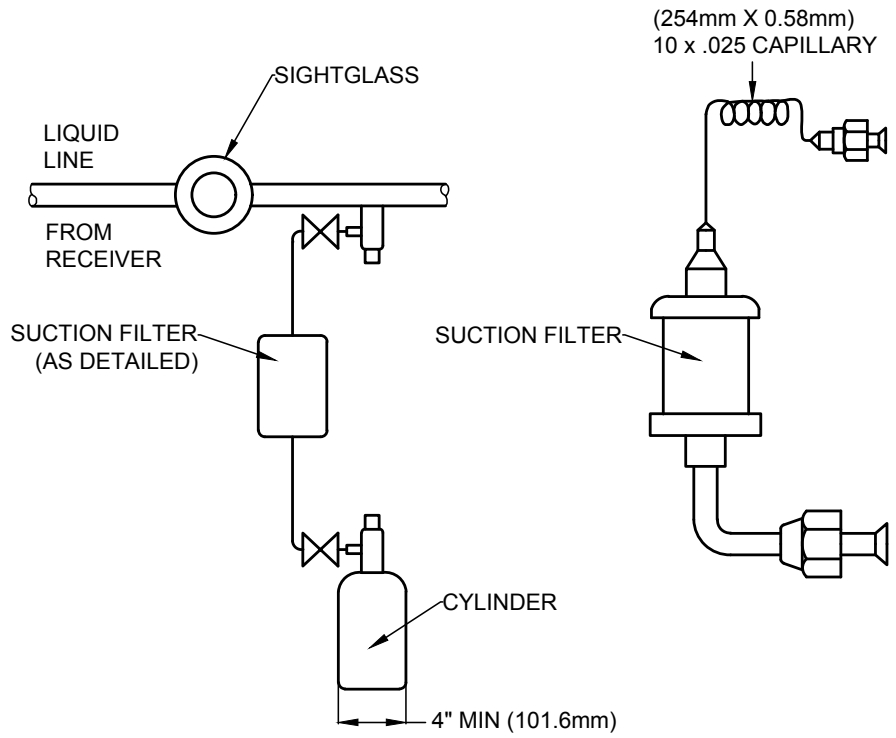
b) Guideline – Piping



c) Oil Input Apparatus



d) Oil – Vapor Mixing Connection



e) Liquid Refrigerant Sampling Apparatus

Fig. 4 Oil Separating Efficiency Test Set-Up

5.2.2 *Conditioning separator*

A conditioning separator is a large oil separator whose purpose is to reduce the oil concentration to or lower than the oil concentration level for equipment under testing (EUT) to be tested. There is no construction detail of the conditioning oil separator. These can be commercially available oil separator.

To determine the need of conditioning oil separator, test should be run without the conditioning oil separator at maximum and minimum refrigerant flow with zero oil input to determine if the compressor used in the test loop is itself circulating so much oil at with condition that the base rate must be reduced to achieve the desired minimum oil flow rate in to the test separator.

NOTE — A commercially available oil separator can be used as conditioning oil separator.

5.2.3 *Oil Reservoir*

The oil to be pumped into the discharge stream before the standard inlet test section shall be stored in a reservoir which shall be maintained at 5.6 °C ± 0.5 above that of the vapor stream at the compressor discharge and refrigerant at pressure corresponding to 4.4 °C ± 0.5 of refrigerant employed in the system.

Oil reservoir shall be provided with an oil pump to circulate and recirculate the oil in reservoir by spraying it through the covering blanket of refrigerant vapour.

5.2.4 *Oil Pump*

It is a positive displacement oil pump to deliver oil at the rate required by the test in to the discharge line together with means for adjusting the rate.

5.2.5 *Oil Input to Discharge Line*

For ensuring uniformity and consistency of the particle size distribution entering the EUT, shall be fed in from a tube of 12.7 mm inside diameter inserted in the bottom of discharge line of 152.4 mm before the inlet of the standard inlet test section. This oil inlet tube shall be ensured not to project more than 3.2 mm into the interior of discharge line.

5.2.6 *Oil Flow Meter*

It is to measure the oil flow rate delivered in to the discharge vapor stream with a measuring range sufficient to measure oil input in to discharge line with accuracy of ± 5 percent of flowrate being measured.

5.2.7 *Oil Makeup*

The oil in the reservoir shall be replenished by:

a) Fresh oil from source outside the system, pumped directly into the reservoir at a rate not exceeding 1.5 times the metered input rate of oil into the test section; and

b) By oil from the compressor in excess of that required to maintain compressor oil level, which is pumped or drained back into the oil reservoir.

5.2.8 *Standard Inlet Test Section*

The standard inlet test section shall comprise of two parts, turbulator and a settling section. Turbulator is a sequence of short radius copper elbows and settling section is a straight horizontal tube of length equal to 50 times of the inside diameter. The standard inlet tube shall be of Type L and have same diameter as the inlet diameter of EUT.

NOTE — The discharge pipe and all components between the outlet of the heat exchanger and the inlet of EUT shall be insulated such that the temperature change is less than 5.6 °C in discharge stream, from outlet of heat exchanger to the inlet of EUT.

5.2.9 *Heater or Heat Exchanger*

Used for cooling or heating of the discharge vapor to desired temperature.

5.2.10 *Standard Inlet Test Section*

This is to establish temperature, solubility and particle size distribution equilibrium. A metered oil input is provided to raise the oil concentration in the discharge stream to the desired level.

5.2.11 *Scavenging Separator*

It is an adequately sized separator to ensure that separation of an oil-rich phase in the receiver does not occur. The adequacy of the size of scavenging separator shall be arrived by running preliminary test to ensure against two phasing in the receiver. For completely miscible refrigerant and oil throughout the range of concentration occurring, scavenging oil separator can be eliminated.

5.2.12 *Inlet Pressure Regulating Valve (IPRV)*

It is used for the purpose of adjusting pressure in the test separator. IPRV can be eliminated if pressure can be adjusted by any other means.

5.2.13 *Receiver*

It is of the construction equipped with a glass tube type level gage glass for the purpose of observing the level of liquid refrigerant in the receiver and for visual confirming that only one liquid phase is present.

5.2.14 *Liquid Line*

It shall be equipped with liquid sampling means for the determination of oil concentration in the liquid refrigerant.

5.2.15 *Refrigerant Liquid Sampling Means*

The liquid refrigerant for oil concentration determination shall be removed from the system into a cylinder, valve, filter and capillary assembly as shown in Fig. 4 The cylinder shall have minimum 100 mm inside diameter, 250 mm length, weight less than 1.4 kg and withstand test pressure.

5.2.16 *Sight Glasses*

The sight glasses S.G.-1 to S.G.-6 shall be positioned as shown in Fig. 4 a) and withstand test pressure.

5.3 Test method

5.3.1 Connect the Equipment under Testing (EUT) to the refrigerant discharge stream of test set-up compressor. Select the desired values for test condition for the following:

a) Refrigerant type;
b) Oil type;
c) Refrigerant flow rate, minimum and maximum;
d) Oil flow rate net = oil flow from reservoir into discharge line;
e) Oil flow rate gross = oil flow net + oil in discharge vapor stream leaving conditioning separator; and
f) Refrigerant pressure entering the EUT.

5.3.2 Adjust the system to desired test condition.

5.3.3 Calibrate the conditioning separator: The oil concentration in the outlet stream of the conditioning separator shall be determined as below:

5.3.3.1 The EUT in position and functioning with no metered oil input, at maximum refrigerant flow and minimum refrigerant flow.

5.3.3.2 With the EUT in position and functioning with maximum metered oil input, at maximum refrigerant flow and minimum refrigerant flow.

5.3.3.3 Plot the data from A and B as per graph shown in Fig. 5.

5.3.3.4 The oil concentration in the conditioned stream for each test run shall be interpolated from this graph.

5.3.3.5 Separate series shall be created for each refrigerant and oil tested by following steps A to D.

5.4 The test shall have to be conducted at equilibrium condition. The equilibrium condition is set to be achieved when three runs of test and the individual observations does not exceed 5 percent of the mean of each quantities as mentioned below:

a) Flow rate of refrigerant through EUT;
b) Oil flow from oil reservoir into discharge line;
c) Oil removed from EUT;
d) Oil concentration in liquid receiver;
e) EUT inlet absolute pressure; and
f) EUT inlet refrigerant temperature.

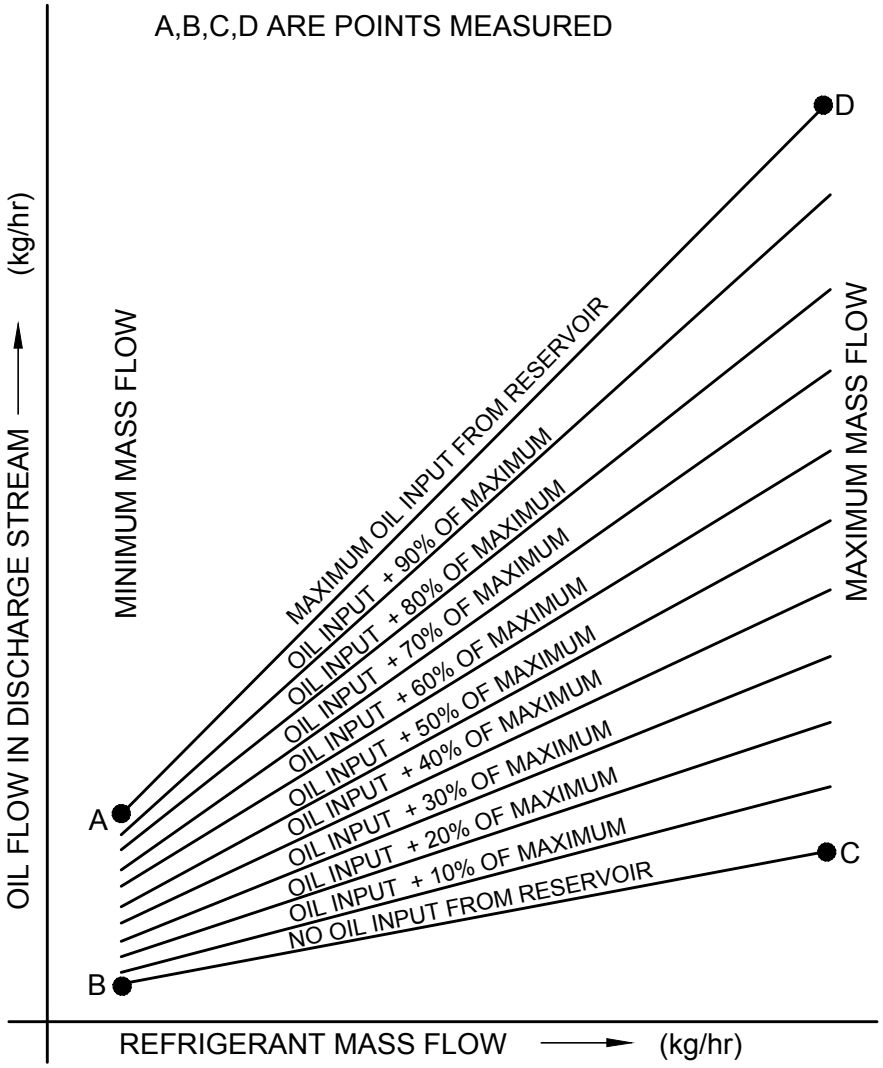


FIG. 5 CALIBRATION GRAPH FOR CONDITIONING SEPARATOR

5.5 Determining Oil Concentration in Liquid from Receiver

5.5.1 *The Refrigerant Sampling Container*

A cylinder setup with a valve, capillary and filter shall be used. The sampling container shall be vacuumed to 0.0026 bar. The weighing scale used for measurement of sampling container shall have an accuracy of 0.5 g. The sampling cylinder shall be connected to the manifold at bottom of the liquid line as shown in Fig. 4 e) and weighed during the refrigerant withdrawal. When the approximately 500 g of refrigerant is withdrawn, the sampling container shall be separated from liquid line.

5.5.2 Cool the sampling container till the refrigerant pressure inside the cylinder is reduced to 51.7 kPa ± 17.2 kPa.

5.5.3 The sampling container shall be brought to room temperature (25 to 29 °C). Rate of refrigerant allowed to escape from the sampling container through capillary. As soon as the refrigerant gas stops escaping from sampling container, it shall be vacuumed to 0.002 6 bar and weight of the sampling container with the oil shall be measured.

6 DATA TO BE RECORDED

The data to be recorded for the capacity tests are given in Table 1.

Table 1 Data to be Recorded

(*Clause* 6)

Sl No.	Data
(1)	(2)
i)	Date of testing
ii)	Manufacturer's name and address
iii)	Manufacturer's name plate data
iv)	Manufacturer's standard rating and conditions of rating
v)	Description/photograph of the EUT
vi)	External diameter of EUT – in mm
vii)	Overall height of EUT – in mm
viii)	The EUT shell height – in mm
ix)	Inlet connection diameter – in mm
x)	Outlet connection diameter – in mm
xi)	Refrigerant flow rate
xii)	Oil quantity separated

6.1 Test report

6.1.1 *General Information*

As a minimum, the test report shall contain the following general information:

a) A reference to this standard;
b) The date;
c) The test laboratory name;
d) The test location;
e) The test supervisor;
f) A description of the test set-up, including equipment location;
g) The nameplate information;
h) Refrigerant flow rate;
j) Refrigerant temperature;
k) Refrigerant pressure; and
m) Measured data – oil separation quantity.

7 MARKING PROVISIONS

7.1 Nameplate Information

The nameplate shall provide the following minimum information in addition to the information required by applicable safety standards:

a) The manufacturer's name or trademark;
b) Manufacturing location address;
c) Any distinctive type or model designation and serial number;
d) Type of oil separator;
e) Oil separation efficiency;
f) Refrigerant type;
g) Design pressure;
h) Operating temperature;
j) Connection type and size; and
k) Type and name of oil.

7.2 Nameplate Requirements

The markings required by the standard shall be clearly legible and durable. Compliance is checked by inspection and by rubbing the marking by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit. The petroleum spirit to be used for the test is aliphatic solvent hexane.

After all the tests of this standard, the marking shall be clearly legible. It shall not be easily possible to remove marking plates nor shall they show curling.

8 MARKING

The product conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the product may be marked with the Standard Mark.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Refrigeration and Air Conditioning Sectional Committee, MED 03

Organization	*Representative(s)*
Indian Institute of Technology, Roorkee	Prof (Dr) Ravi Kumar (***Chairman***)
Annapurna Electronics and Services Ltd, Hyderabad	Shri G. K. Prasad Shri J. S. Sastry (*Alternate*)
Bureau of Energy Efficiency, New Delhi	Shri Sameer Pandita Shri Kamal Shaikh (*Alternate*)
Blue Star Ltd, Mumbai	Shri Jitendra Bhambure Shri Sunil Jain (*Alternate*)
BSH Household Appliances Manufacturing Pvt Ltd, Chennai	Shri Vijaya Kumar Loganathan Shri Anand Balasubramanian (*Alternate*)
Carrier Aircon Ltd, Gurugram	Shri Bimal Tandon Shri D. Bhattacharya (*Alternate*)
Central Power Research Institute, Bengaluru	Shri A. R. Ravi Kumar Shri Gujjala B. Balaraja (*Alternate*)
Centre for Science and Environment, New Delhi	Shri Chandra Bhushan
Consumer Education and Research Centre, Ahmedabad	Ms Sweta Mahajan
Danfoss Industries Pvt Ltd, Gurugram	Shri Madhur Sehgal Shri K. L. Nagahari (*Alternate* I) Shri M. N. S. V. Kiran Kumar (*Alternate* II)
Electrical Research and Development Association, Vadodara	Shri Gautam Brahmbhatt Shri Rakesh Patel (*Alternate*)
Emerson Climate Technologies(India) Pvt Ltd, Karad	Shri Chethan Tholpady Shri D. P. Despande (*Alternate*)
Godrej & Boyce Mfg Co Ltd, Mumbai	Shri Burzin J. Wadia Shri Abhijit A. Acharekar (*Alternate*)
Honeywell International India Pvt Ltd, Gurugram	Shri Sudhir Kavalath Dr Nitin Karwa (*Alternate*)
Indian Institute of Chemical Engg, Kolkata	Dr D. Sathiyamoorthy Dr Sudip K. Das (*Alternate*)
Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE), New Delhi	Dr Jyotirmay Mathur Shri Ashish Rakheja
Ingersoll Rand, Bangaluru	Shri Mittakola Venkanna Shri Jeyaprakash Gurusamy (*Alternate*)
International Copper Association India, Mumbai	Shri Sanjeev Ranjan Shri Shankar Sapaliga (*Alternate*)
Intertek India Pvt Ltd, New Delhi	Shri Balvinder Arora Shri C. M. Pathak (*Alternate*)
LG Electronics India Pvt Ltd, New Delhi	Shri Aditya Anil Shri Rajat Shrivastava (*Alternate*)
National Thermal Power Corporation, Noida	Shri D. K. Suryanarayan Shri S. K. Jha (*Alternate*)

Organization	*Representative(s)*
Refrigeration & Airconditioning Manufacturers Association, New Delhi	Shri Gurmeet Singh Shri R. K. Mehta (*Alternate*)
Samsung India Electronics Pvt Ltd, Noida	Shri Gaurav Choudhary Shri Kalicharan Sahu (*Alternate*)
Sierra Aircon Pvt Ltd, Gurugram	Shri Devesh Mudgal
Spirotech Heat Exchanger Pvt Ltd, Bhiwadi	Shri Sunil Bhardwaj Shri Dwijesh Gautam (*Alternate*)
The Chemours India Pvt Ltd, Gurugram	Shri Vikas Mehta Shri Nishit Shah (*Alternate*)
The Energy and Resources Institute, New Delhi	Shri P. S. Chidambaram Shri Girish Sethi (*Alternate*)
UL India Pvt Ltd, Bengaluru	Shri V. Manjunath Shri Satish Kumar (*Alternate*)
Voltas Ltd, Mumbai	Shri Srinivasu Moturi Shri A. D. Kumbhar (*Alternate*)
Voluntary Organizationn in Interest of Consumer Voice, New Delhi	Shri H. Wadhwa Shri B. K. Mukhopadhyay (*Alternate*)
In personal capacity (*H.No. 03, Savita Vihar, Delhi*)	Shri J. K. Agrawal
In personal capacity (*506/2, Kirti Apartments, Mayur Vihar, Phase-1 Extension, Delhi*)	Shri P. K. Mukherjee
BIS Directorate General	Shri Rajneesh Khosla, Scientist 'E' and Head (MED) [Representing Director General (*Ex-officio*)]

Member Secretary

Ms Khushbu Jyotsna Kindo
Scientist 'C' (MED), BIS

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc No.: MED 03 (12806).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

Regional Offices:		*Telephones*
Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	2323 7617, 2323 3841
Eastern	: 1/14 C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi, KOLKATA 700054	2337 8499, 2337 8561, 2337 8626, 2337 9120
Northern	: Plot No. 4-A, Sector 27-B, Madhya Marg, CHANDIGARH 160019	265 0206, 265 0290
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	2254 1216, 2254 1442, 2254 2519, 2254 2315
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East), MUMBAI 400093	2832 9295, 2832 7858, 2832 7891, 2832 7892

Branches : AHMEDABAD. BENGALURU. BHOPAL. BHUBANESHWAR. COIMBATORE. DEHRADUN. DURGAPUR. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. JAMMU. JAMSHEDPUR. KOCHI. LUCKNOW. NAGPUR. PARWANOO. PATNA. PUNE. RAIPUR. RAJKOT. VISAKHAPATNAM.

Published by BIS, New Delhi